CLAIMS

What is claimed is:

1. An acceleration sensor comprising an acceleration sensor element which comprises:

a mass portion located in the center of the acceleration sensor element;

a top plate of the mass portion fixed on an upper end of the mass portion;

a rectangular thick support frame surrounding and being at a distance from the mass portion;

a top plate of the frame fixed on an upper end of the frame;

four elastic support arms bridging the mass portion top plate and the frame top plate and hanging the mass portion in the center of the frame; and

strain gauges formed on the elastic support arms;

the mass portion top plate having a portion bonded to the mass portion upper end and a portion protruding toward each of the elastic support arms from the bonded portion of the mass portion top plate, so that a cross section of the mass portion top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm; and

the frame top plate having a portion bonded to the frame upper end and a portion protruding toward each of the elastic support arms from the bonded portion of the frame top plate, so that a cross section of the frame top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm.

2. An acceleration sensor as set forth in claim 1, wherein the protruding portion of the mass portion top plate is formed from the mass portion top plate by a groove provided on a side surface of the mass portion neighboring on the upper end of the mass portion along the mass portion top plate between the mass portion top plate and the mass portion upper end, and

the protruding portion of the frame top plate is formed from the frame top plate by a groove provided on an inner side surface of the frame neighboring on the upper end of the frame along the frame top plate between the frame top plate and the frame upper end.

3. An acceleration sensor as set forth in claim 2, wherein a surface of the mass portion top plate facing the mass portion upper end is substantially the same in shape and in area as a region surrounded by crossing lines of a plane including the mass portion upper end with planes extended along the side surfaces of the mass portion toward the mass portion top plate from the side surfaces of the mass portion, and

a surface of the frame top plate facing the frame upper end is substantially the same in shape and in area as a region provided between crossing lines of a plane including the frame upper end with planes extended along the inner side surfaces of the frame toward the frame top plate from the inner side surfaces of the frame and crossing lines of a plane including the frame upper end with planes extended along an outer side surfaces of the frame toward the frame top plate from the outer side surfaces of the frame.

4. An acceleration sensor as set forth in claim 2, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.

5. An acceleration sensor as set forth in claim 3, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.

6. An acceleration sensor comprising an acceleration sensor element which comprises:

a square mass portion located in the center of the acceleration sensor element;

a square top plate of the mass portion fixed on an upper end of the mass portion;

a square thick support frame surrounding and being at a distance from the mass portion;

a square top plate of the frame fixed on an upper end of the frame;

four elastic support arms bridging the mass portion top plate and the frame top plate and hanging the mass portion in the center of the frame; and

strain gauges formed on the elastic support arms;

the mass portion top plate having a portion bonded to the mass portion upper end and a

portion protruding toward each of the elastic support arms from the bonded portion of the mass portion top plate, so that a cross section of the mass portion top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm; and

the frame top plate having a portion bonded to the frame upper end and a portion protruding toward each of the elastic support arms from the bonded portion of the frame top plate, so that a cross section of the frame top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm.

7. An acceleration sensor as set forth in claim 6, wherein the protruding portion of the mass portion top plate is formed from the mass portion top plate by a groove provided on a side surface of the mass portion neighboring on the upper end of the mass portion along the mass portion top plate between the mass portion top plate and the mass portion upper end, and

the protruding portion of the frame top plate is formed from the frame top plate by a groove provided on an inner side surface of the frame neighboring on the upper end of the frame along the frame top plate between the frame top plate and the frame upper end.

8. An acceleration sensor as set forth in claim 7, wherein a surface of the square mass portion top plate facing the mass portion upper end is substantially the same in shape and in area as a cross section of other part of the square mass portion than the grooves on the mass portion, the cross section being parallel to the upper end of the mass portion, and

a surface of the square frame top plate facing the frame upper end is substantially the same in shape and in area as a cross section of other part of the square frame than the grooves on the frame, the cross section being parallel to the upper end of the frame.

9. An acceleration sensor as set forth in claim 7, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.

10. An acceleration sensor as set forth in claim 8, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.

11. An acceleration sensor comprising:

an acceleration sensor element which comprises:

a mass portion located in the center of the acceleration sensor element,

a top plate of the mass portion fixed on an upper end of the mass portion,

a rectangular thick support frame surrounding and being at a distance from the mass portion,

a top plate of the frame fixed on an upper end of the frame,

four elastic support arms bridging the mass portion top plate and the frame top plate and hanging the mass portion in the center of the frame, and

strain gauges formed on the elastic support arms,

the mass portion top plate having a portion bonded to the mass portion upper end and a portion protruding toward each of the elastic support arms from the bonded portion of the mass portion top plate, so that a cross section of the mass portion top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm, and

the frame top plate having a portion bonded to the frame upper end and a portion protruding toward each of the elastic support arms from the bonded portion of the frame top plate, so that a cross section of the frame top plate on a boundary between the bonded portion and the protruding portion is larger than a cross section connecting the protruding portion to the elastic support arm;

a first regulation plate mounted with a predetermined gap with the mass portion top plate to cover the acceleration sensor element and fixed on a top surface of the frame top plate by a paste; and

a second regulation plate to which a bottom surface of the frame is bonded by the paste with a second predetermined gap between a bottom surface of the mass portion and a top surface of the second regulation plate;

wherein the paste is a mixture of hard plastic balls with adhesive.

12. An acceleration sensor as set forth in claim 11, further comprising a protection case having a side frame and an inner bottom plate surrounded by the side frame,
wherein the acceleration sensor element is installed in the protection case, the inner bottom plate working as the second regulation plate.

13. An acceleration sensor as set forth in claim 11, wherein the protruding portion of the mass portion top plate is formed from the mass portion top plate by a groove provided on a side surface of the mass portion neighboring on the upper end of the mass portion along the mass portion top plate between the mass portion top plate and the mass portion upper end, and
the protruding portion of the frame top plate is formed from the frame top plate by a groove provided on an inner side surface of the frame neighboring on the upper end of the frame along the frame top plate between the frame top plate and the frame upper end.

14. An acceleration sensor as set forth in claim 13, wherein a surface of the mass portion top plate facing the mass portion upper end is substantially the same in shape and in area as a region surrounded by crossing lines of a plane including the mass portion upper end with planes extended along the side surfaces of the mass portion toward the mass portion top plate from the side surfaces of the mass portion, and
a surface of the frame top plate facing the frame upper end is substantially the same in shape and in area as a region provided between crossing lines of a plane including the frame upper end with planes extended along the inner side surfaces of the frame toward the frame top plate from the inner side surfaces of the frame and crossing lines of a plane including the frame upper end with surfaces extended along an outer side surfaces of the frame toward the frame top plate from the outer side surfaces of the frame.

15. An acceleration sensor as set forth in claim 13, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.

16. An acceleration sensor as set forth in claim 14, wherein each of the grooves is equal to or longer than the width of the elastic support arm neighboring on the groove, and is 1 to 30 μm wide and 1 to 100 μm deep.